

Burden of Self-Reported Acute Diarrheal Illness in FoodNet Surveillance Areas, 1998–1999

Beth Imhoff,¹ Dale Morse,² Beletshachew Shiferaw,⁴ Marguerite Hawkins,⁵ Duc Vugia,⁶ Susan Lance-Parker,² James Hadler,⁷ Carlota Medus,⁸ Malinda Kennedy,¹ Matthew R. Moore,¹ and Thomas Van Gilder,¹ for the Emerging Infections Program FoodNet Working Group^a

¹Foodborne and Diarrheal Diseases, Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, and ²Georgia Division of Public Health, Atlanta, Georgia; ³New York State Department of Health, Albany; ⁴Department of Human Services, Oregon Health Division, Portland; ⁵University of Maryland School of Medicine, Baltimore; ⁶California Department of Health Services, Berkeley; ⁷Connecticut Department of Public Health, Hartford; and ⁸Minnesota Department of Health, Minneapolis

To assess trends in the burden of acute diarrheal illness, the Foodborne Diseases Active Surveillance Network (FoodNet) conducted a population-based telephone survey during 1998–1999, using a random-digit-dialing, single-stage Genesys-ID sampling method. During the 12-month study period, 12,755 persons were interviewed; after the exclusion of persons with chronic diarrheal illnesses, 12,075 persons were included in the analysis; 6% ($n = 645$) reported having experienced an acute diarrheal illness at some point during the 4 weeks preceding the interview (annualized rate, 0.72 episodes per person-year). Rates of diarrheal illness were highest among children aged <5 years (1.1 episodes per person-year) and were lowest in persons aged ≥ 65 years (0.32 episodes per person-year). Twenty-one percent of persons with acute diarrheal illness sought medical care as a result of their illness. Diarrheal illness imposes a considerable burden on the US population and health care system.

Improvements in sanitation and hygiene in the United States over the past century have contributed to a decline in the infectious causes of diarrheal disease. Still, foodborne causes of acute diarrheal illness continue to impose a significant burden on the population's health. An estimated 76 million cases of foodborne infectious disease occur each year in the United States, and diarrhea is a major symptom of most of these infections [1].

To quantify more precisely the burden of self-reported acute diarrheal illness in the United States, the Foodborne Diseases Active Surveillance Network (FoodNet) conducted a 12-month population-based

telephone survey during 1996–1997. Six percent of respondents reported having had an acute diarrheal illness at some point during the 4 weeks prior to the interview, yielding an average annualized rate of 0.75 episodes of acute diarrheal illness per person-year [2]. Generalized to the United States population, this suggests that there were 200 million episodes of acute diarrheal illness per year in 1996–1997.

In 1997, the US Department of Agriculture Food Safety and Inspection Service (USDA FSIS) began implementing Pathogen Reduction/Hazard Analysis and Critical Control Point regulations to improve the safety of the nation's supply of meat, poultry, and egg products and to reduce the incidence of foodborne illness. To continue tracking the burden of self-reported diarrheal illness, we undertook a second 12-month population-based telephone survey during 1998–1999.

METHODS

FoodNet, the primary foodborne disease component of the Emerging Infections Program of the Centers for Disease Control and Prevention (CDC), is a collaborative project among the CDC, the USDA FSIS, the US

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^a Working group members are listed at the end of the text.

Reprints or correspondence: Frederick Angulo, Foodborne and Diarrheal Diseases, Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, 1600 Clifton Rd., MS D-63, Atlanta, GA 30333 (fangulo@cdc.gov).

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Food and Drug Administration, and selected state health departments [3, 4]. The population-based survey was administered between 1 July 1998 and 30 June 1999 in the FoodNet surveillance areas (also known as “FoodNet sites”). These included Connecticut, Georgia, Minnesota, and Oregon and selected counties in California (Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma), Maryland (Anne Arundel, Baltimore, Baltimore City, Carroll, Harford, and Howard), and New York (Genesee, Livingston, Monroe, Ontario, Orleans, Wayne, and Yates). The survey population size was 29 million persons, or ~11% of the 1998 total US population.

After screening telephone numbers to remove business and nonworking telephone numbers, households were contacted by telephone using a random-digit-dialing, single-stage Genesys-ID sampling method, a method used in the Behavioral Risk Factor Surveillance System [5, 6]. One individual per household was randomly selected from a roster of household members. Verbal consent was obtained from the individual before the interview. Consent from a parent or guardian was obtained before the interview for adolescents aged 12–17 years. Parents or guardians responded for children aged <12 years. The goal was to interview 150 persons per site each month. All interviews were conducted in English. Respondents were asked questions about symptoms of enteric illness, underlying medical conditions, and demographic characteristics (e.g., age, race, education, and annual household income) (see Appendix). The research was conducted in accordance with guidelines for human experimentation as specified by the US Department of Health and Human Services.

The respondents were asked whether they had experienced diarrhea (defined as ≥ 3 loose stools during any 24-h period) in the 4 weeks before the interview (figure 1). The question about illness was worded as follows: “In the past 4 weeks, have you had any of the following symptoms: (a) stomach cramps, (b) vomiting, (c) fever, or (d) diarrhea, defined as 3 or more loose stools or bowel movements in any 24-hour period.” If a respondent reported diarrhea, he or she was asked whether blood was present in the stool. If the respondent reported diarrhea or vomiting, he or she was asked the duration of the illness, the ability to perform usual activities, and medical action taken as a result of the illness (e.g., visiting a physician, visiting a hospital emergency department, being hospitalized for at least 1 night, receiving antibiotics, or receiving antidiarrheal medication). Participants were not asked whether a physician prescribed the antibiotics or antidiarrheal medications that they received. Respondents also were not asked about respiratory symptoms or illnesses; hence, diarrhea associated with respiratory illness was not excluded from our analysis.

We defined an acute diarrheal episode as self-reported diarrhea (≥ 3 loose stools within 24 h) and an acute diarrheal

illness as self-reported diarrhea (≥ 3 loose stools within 24 h) that lasted >1 day or was associated with impaired daily activity (e.g., missed work or school). For the analysis of acute diarrheal illness, we excluded persons who reported vomiting with no diarrhea, persons with a chronic diarrheal illness (e.g., Crohn disease or irritable bowel syndrome), and persons who had had part of their stomach surgically removed (figure 1). Persons who responded “don’t know” or who refused to answer a question were not included in the analysis of that question. We defined “seeking medical care” as visiting a physician, visiting a hospital emergency department, or being hospitalized for at least 1 night.

We grouped respondents aged >12 years into the following education levels: did not complete high school, completed high school, college graduate, and completed a graduate degree. Persons who reported living in urban or suburban areas were categorized as “urban dwellers,” and persons who reported living in rural, town, village, or farm areas were categorized as “rural dwellers.” Similar to the 1996–1997 analysis, we created a single variable for race and ethnicity; if a respondent reported his or her ethnicity to be Hispanic, we classified their race/ethnicity as Hispanic, regardless of the respondent’s race [2].

Data were analyzed using weighted proportions, to compensate for unequal probabilities of selection and to allow for population estimates. Unequal probabilities of selection were accounted for by weighting the data, using the number of eligible respondents per household and the number of telephone lines in each household. Using 1998 projected census numbers, we adjusted for age and sex so that the survey respondents were more demographically representative of the population of the FoodNet surveillance area. The data were analyzed with SAS software, version 6.12 (SAS), Epi Info 6, version 6.04 (CDC, Atlanta, GA), and Software for Survey Data Analysis, version 7.5 (Research Triangle Institute). We compared our results with those of a similar telephone population-based survey conducted in the FoodNet surveillance area during 1996–1997 [2].

RESULTS

Demographic characteristics. A total of 12,755 respondents completed the survey. On the basis of 1998 postcensus numbers, the demographic characteristics of the respondents were broadly similar to those of the resident population of the FoodNet sites, with the exception of Hispanics, who were underrepresented (11% of the US population and 5% of study participants), and female respondents (51% of the US population and 57% of study participants), who were slightly overrepresented. The median ages of study participants and of the US population were 40 and 36 years, respectively. The range of median annual income, which was reported by 78% of respondents, was \$30,000–\$59,999 for study participants, which

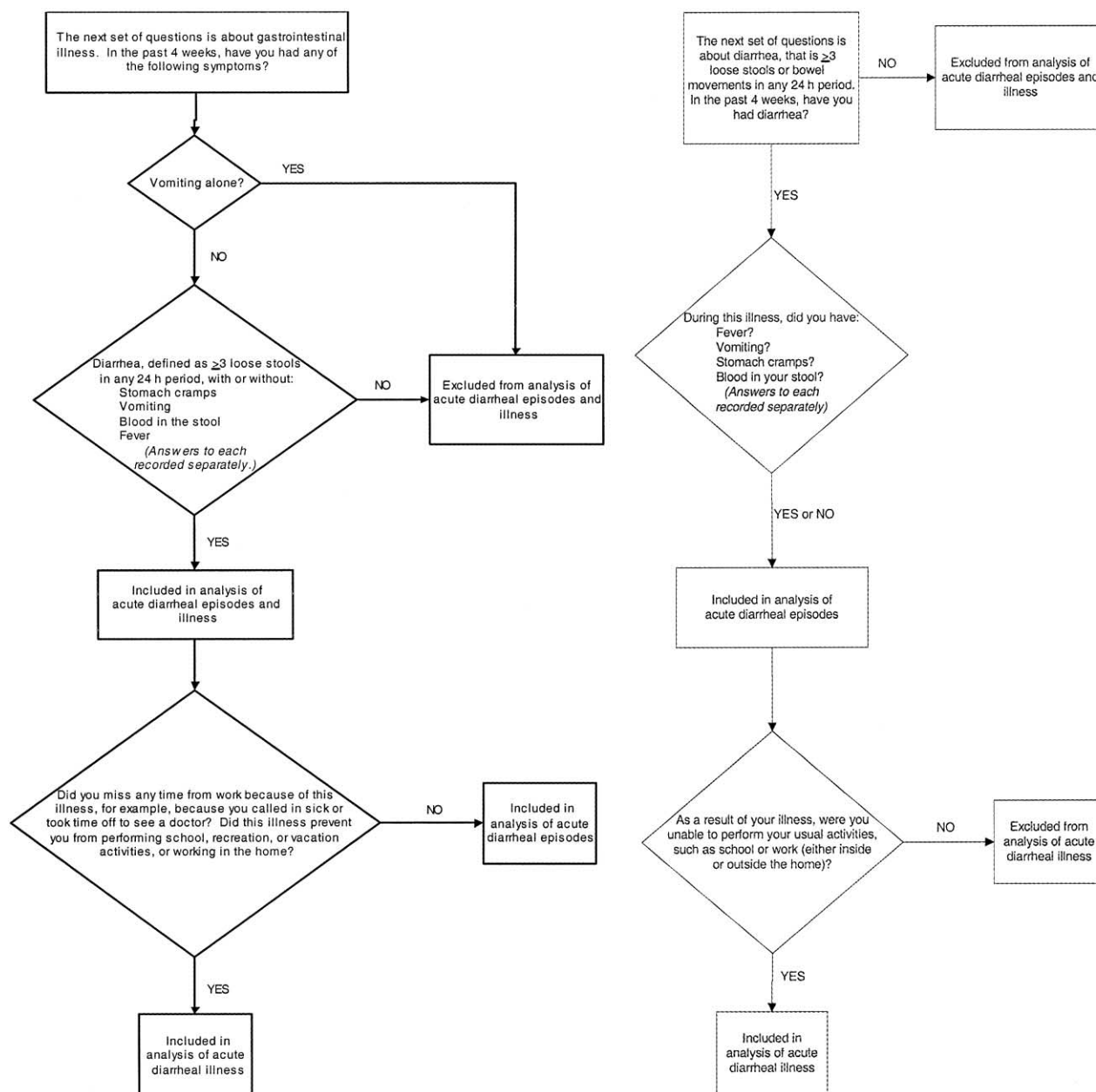


Figure 1. Diagram summarizing the analysis of questions related to acute diarrheal episodes and illness: A, 1998–1999 survey; B, 1996–1997 survey.

includes the median income for the US population (\$38,885) [7].

Acute diarrheal illness. Of the 12,755 persons interviewed, 680 persons reported that they had chronic diarrhea or had had part of their stomach surgically removed and therefore were excluded from the analysis. Of the remaining 12,075 respondents, 1192 (10%) reported having had an acute diarrheal episode during the previous 4 weeks, which corresponds to a rate of 1.3 episodes of acute diarrhea per person-year. Of these respondents, 645 reported acute diarrheal illness (an acute diarrheal episode with a duration >1 day or impaired daily ac-

tivities) during the 4 weeks before the interview, which corresponds to a prevalence of 6% and a weighted rate of 0.72 episodes of acute diarrheal illness per person-year. The median duration of acute diarrheal illness was 2 days (25% and 75% quartiles, 2 and 3 days, respectively; range, <1–30 days). The median number of days with diarrhea did not vary between seasons.

The age groups with the highest prevalence of self-reported acute diarrheal illnesses were children aged <5 years (9% of respondents) and adults aged 25–44 years (8%) (table 1). Persons aged ≥65 years had the lowest rate (2% of respondents).

Table 1. Association between demographic characteristics of 12,755 persons and self-reported episodes of acute diarrhea or acute diarrheal illness during the 4 weeks preceeding a telephone interview, FoodNet population survey, 1998–1999.

Characteristic	All respondents, %	Respondents with episode(s) of acute diarrhea (n = 1192)		Respondents with acute diarrheal illness (n = 645)		Respondents who sought medical care for diarrheal illness, %	
		As % of all respondents	Annualized rate ^a	As % of all respondents	Annualized rate ^a	Who did not submit a stool sample (n = 143)	Who submitted a stool sample (n = 23)
Sex							
Male	49	10	1.3	5	0.68	23	19
Female	51	10	1.3	6	0.74	19	13
Age in years							
<5	7	13	1.6	9	1.1	31	15
5–14	14	7	0.93	4	0.55	27	11
15–24	13	8	1.1	4	0.54	14	0
25–44	32	13	1.7	8	0.99	16	23
45–64	22	9	1.2	4	0.56	27	8
≥65	12	5	0.66	2	0.32	28	46
Race/ethnicity							
White	76	10	1.3	6	0.74	21	16
African American	11	6	0.82	4	0.50	19	35
Asian	4	8	1.1	5	0.63	10	0
Native American	1	16	2.1	5	0.60	0	...
Hispanic	8	10	1.3	5	0.67	32	9
Education level ^b							
Did not complete high school	19	8	1.0	4	0.58	22	32
Completed high school	44	10	1.3	5	0.66	17	8
College graduate	27	11	1.4	6	0.77	22	18
Graduate degree	11	11	1.5	6	0.73	13	23
Area of residence							
Urban	68	10	1.3	5	0.71	22	13
Rural	32	9	1.2	5	0.71	20	24
Overall		10	1.3	6	0.72	21	16

^a Episodes or illnesses per person-year.

^b Persons aged >12 years.

The prevalence of acute diarrheal illness was similar among men (5% of respondents) and women (6%) and was highest among whites (6%). Urban and rural dwellers experienced identical prevalences (5% of respondents), and the prevalence of acute diarrheal illness did not vary significantly between states. Of respondents with an acute diarrheal illness, 58% reported abdominal cramps, 26% reported vomiting, 35% reported fever, and 6% reported blood in their stool. Of persons who had a diarrheal illness and reported having blood in their stool, 54% reported having “a small amount,” 36% reported “a medium amount,” and 10% reported “a large amount.” Of persons with acute diarrheal illness, 33% received antidiarrheal medications, and 12% received an antibiotic. Of persons with an acute diarrheal illness who sought medical care, 38% received an antibiotic.

The reported prevalence of acute diarrheal illnesses varied slightly by season; it was higher during the winter months (7% of respondents) than in spring (5%), summer (5%), or fall (5%). The severity of symptoms (defined as presence of blood in stool, fever, and vomiting) was greatest during winter. The prevalence of concomitant vomiting was highest during winter (33% of respondents in winter, 18%, in fall, 22% in spring, and 25% in summer) (table 2). Fever also was more common in winter (41% of respondents) than in fall (33%), spring (32%), or summer (30%). More persons reported blood in their stool in winter (9% of respondents) than in fall (5%), spring (7%), or summer (<1%). However, a higher proportion of persons sought care in spring (25% of respondents) and summer (25%), compared with winter (20%) and fall (15%).

The prevalence of acute diarrheal illness was not markedly

Table 2. Seasonal weighted prevalence of acute diarrheal illnesses and associated features during the 4 weeks preceeding a telephone interview, FoodNet population survey, 1998–1999.

Feature reported	Prevalence of reported feature, % of respondents				
	In fall (n = 3038)	In winter (n = 3307)	In spring (n = 3069)	In summer (n = 2661)	Overall (n = 12,075)
Acute diarrheal illness	5	7	5	5	6
Medical care sought for diarrheal illness	15	20	25	25	21
Diarrhea-associated symptoms					
Fever	33	41	32	30	35
Blood in stool	5	9	7	0.5	6
Vomiting	18	33	22	25	26
Abdominal cramps	65	53	60	56	58

NOTE. Fall: September, October, and November; winter: December, January, and February; spring: March, April, and May; summer: June, July, and August.

elevated in persons with underlying medical conditions. Of the 349 respondents with an immunocompromising condition (e.g., cancer or HIV infection), 7% reported having an acute diarrheal illness during the 4 weeks prior to the interview, compared with 5% of respondents without an immunocompromising condition ($P = .3$). Of 47 persons who were receiving radiation or chemotherapy, 8% had had an acute diarrheal illness during the 4 weeks before the interview, compared with 5% of other respondents ($P = .5$).

Medical action. Twenty-one percent of respondents with an acute diarrheal illness during the 4 weeks before the interview sought medical care (table 1). Care-seeking behavior varied by age, educational level, and sex. The prevalence of seeking medical care for diarrheal illness was highest for children aged <5 years and persons aged ≥ 65 years (31% and 28% of respondents, respectively). Male respondents sought medical care more frequently than did female respondents (23% vs. 19% of respondents), although this difference was not statistically significant ($P = .3$). A higher percentage of Hispanic persons with an acute diarrheal illness sought medical care (32% of respondents) than did whites (21%), African Americans (19%), or Asians (10%).

Of ill respondents who visited a physician, 16% were asked to provide a stool specimen, and 97% of those complied with that request. Stool specimens were most frequently requested from men, persons aged ≥ 65 years, African Americans, persons who lived in rural areas, and those with a graduate degree. Nine percent of persons with a diarrheal illness who visited a health care provider and 2% of all persons with a diarrheal illness were hospitalized for at least 1 night. The median duration of hospitalization was 3 nights (25% and 75% quartiles, 2 and 10 nights, respectively; range, 1–20 nights).

Comparison of the 1996–1997 and 1998–1999 surveys.

The estimated annual incidence rate of acute diarrheal illness in 1996–1997 was 0.75 episodes per person-year, and 1998–1999 it was 0.72 episodes per person-year (4-week prevalences

among respondents, 6% for both), which indicates little interval change. Results from both surveys indicated that the prevalence of diarrheal illness was highest among children aged <5 years (9% of respondents in both 1996–1997 and 1998–1999) and lowest among persons aged ≥ 65 years (3% in 1996–1997 and 2% in 1998–1999). Among persons who reported diarrheal illness in 1998–1999, blood in stool was more common than in 1996–1997 (6% vs. 1% of respondents; $P = .001$).

More persons reported seeking medical care for their illness in 1998–1999 (21% of respondents) than in 1996–1997 (12%); however, the questions regarding seeking medical care were not asked in exactly the same way in the 2 surveys. The reported percentage of respondents who sought medical care and were asked to provide a stool specimen was lower in 1998–1999 (16%) than it was in 1996–1997 (21%). Thus, the estimated likelihood of submitting a stool specimen among those who sought care was 3.4% (0.21×0.16) in 1998–1999 and was 2.5% (0.12×0.21) in 1996–1997.

DISCUSSION

Our results indicate that acute diarrheal illnesses continue to impose a significant health burden on the US population. Projecting 0.72 episodes of acute diarrheal illness per person-year to the US population of 272,690,813 in 1999, we estimate that 195 million episodes of acute diarrheal illness occurred nationally during the 1-year study period. An estimated 41 million persons with an acute diarrheal illness consulted a physician, 6.6 million provided a stool specimen for testing, and 3.6 million were hospitalized at least overnight. Our results also indicate that the prevalence of self-reported acute diarrheal illness was highest among children aged <5 years and during the winter months.

Although the questions concerning diarrhea asked by FoodNet in 1996–1997 were slightly different than the 1998–1999 questions, we accounted for these difference in our anal-

ysis (figure 1). The 1996–1997 survey questions concerning diarrhea asked only about diarrhea, whereas the 1998–1999 survey questions asked about both vomiting and diarrhea. We accounted for this difference by excluding from the analysis persons who reported vomiting only. Therefore, differences in the prevalence of diarrhea are not easily explained by the difference in how the questions were worded. The measured rate of acute diarrheal illness was, in fact, similar in the 2 surveys. Among persons with diarrhea, blood in the stool was more common in 1998–1999 (30 respondents [6%]) than in 1996–1997 (4 respondents [1%]), and the submission of stool samples was less common in 1998–1999 (23 respondents [16%]) than in 1996–1997 (17 respondents [21%]). Although statistically significant, these differences may not indicate public health importance, because the numerators are very small. We do not know whether this difference was due to a change in reporting or to a true difference. The 1998–1999 base survey population included more US counties than the 1996–1997 survey population, which could account for some of the differences.

Several prospective community-based studies have described rates of diarrhea in specific areas in the United States. The definition of diarrhea varied among studies, making comparison complex. These differences, along with local population differences, may partly account for differences in estimates. A study conducted in Cleveland, Ohio, during 1948–1957 estimated an overall rate of diarrheal illness of 0.83 episodes per person-year on the basis of 2675 person-years of observation [8]. Participants who reported respiratory symptoms associated with diarrhea were excluded from this estimate.

A similar study conducted in Tecumseh, Michigan, during 1965–1971 evaluated prospectively the incidence of acute enteric illness (i.e., vomiting, diarrhea, or other enteric symptoms) [9]. For 850 families, each enrolled for 1 year (for a total of 4095 person-years of observation), the incidence of diarrhea with or without vomiting was 0.63 episodes per person-year. Because young children and mothers of young children were overrepresented in the sample, the rates of illness were age adjusted by Garthright et al. [10], who reported the age-adjusted rate of diarrhea to be 0.52 episodes per person-year. As in our study, the Tecumseh study revealed that rates of diarrhea were highest during the winter months and among young children (aged <5 years) [11]. A prospective study of enteric illness among 42 families in 1976 reported 1.5 episodes of acute enteric illness per person-year [12]. This estimate did not exclude persons with vomiting alone or those with other milder intestinal symptoms. However, similar to our study, the 1976 study found that rates of acute enteric illness were highest among children aged <5 years and among those interviewed during winter. A telephone survey to assess use of filtered public drinking water conducted in Washington, D.C., in 1993 [13] interviewed 1197 household members from 462 different households. The av-

erage rate of diarrhea, defined as ≥ 3 loose or watery stools during a 24-h period, was 0.8 episodes per person-year (this rate was not age adjusted). Thus, 4 prospective population-based studies in the United States conducted in the past 5 decades found similar incidences of acute diarrheal illness.

Studies conducted in other developed countries have reported rates of diarrhea of 0.2–0.95 episodes per person-year [14–18]. A large community cohort study conducted in England reported a rate of infectious intestinal disease of 0.2 episodes per person-year [16]. Participants were randomly selected from the patient lists of 70 general practices. Participants completed and returned postcards weekly indicating whether they were experiencing symptoms of enteric illness. If the participant reported symptoms, he or she was expected to mail a stool specimen to the public health laboratory. On enrollment, the community cohort was asked to retrospectively report episodes of diarrhea in the month before recruitment. Because the cohort was asked to report retrospectively, stool specimens were not requested. The rate of retrospectively self-reported diarrhea was 0.6 episodes per person-year, almost 3 times higher than the rate in the prospective study. The authors attributed the higher rate to “telescoping,” which is a theoretical tendency for participants to report events in the distant past as having occurred in the recent past [16].

Although telescoping may occur in retrospective studies, Monto and Koopman [11] found that, during their prospective study of enteric illness, the rate of self-reported diarrhea decreased when participants were asked to provide a stool specimen. This suggests that persons who are asked to provide a stool specimen when they are ill may deny symptoms to avoid submitting a specimen. Further studies are needed to better understand this issue.

A study conducted in The Netherlands in 1991 reported the age- and sex-adjusted rate of gastroenteritis to be 0.45 episodes per person-year [17]. Twenty-two percent of persons with enteric illness consulted a physician, which is similar to our findings. A cross-sectional study carried out in Great Britain during 1992–1993 found rate of diarrhea of 0.95 episodes per person-year [18]. Although these results show the variation in estimates of diarrheal disease in developed countries around the world, they all show, nonetheless, that the incidence of diarrheal illness remains high and poses a significant health burden on populations from developed countries around the world.

Our study had several limitations that are inherent to telephone surveys. Persons who refused to be interviewed may have been somehow different from persons who agreed to participate. The study was limited to persons who spoke English, hence it excluded a portion of the US population. Persons who did not have a telephone were not included in our sample, which probably resulted in the systematic exclusion of persons of low socioeconomic status and institutionalized persons (e.g.,

persons in jails, mental institutions, and long-term health care facilities). In the context of extrapolating the acute diarrheal illness estimates to the entire US population, the study sample may not have been truly representative of the US population. However, a comparison of the FoodNet population to the US population showed that there are few differences between the populations [7]. Finally, the study did not include enteric symptoms that are associated with respiratory infection. It is possible that a portion of the reported acute diarrheal illnesses were secondary to other illnesses, such as respiratory infection.

Although the rate of acute diarrheal illness remained relatively constant in 1998–1999, compared with FoodNet estimates for 1996–1997, diarrheal illnesses continue to impose a considerable burden on both the population and the health care system. Further studies that combine the burden of self-reported diarrheal illness with the cause-specific burden of acute diarrheal illness in the United States are necessary to evaluate the effect of measures suggested by the USDA FSIS and to identify preventable risk factors.

FOODNET WORKING GROUP MEMBERS

CDC: Frederick Angulo, Timothy Barrett, Michael Beach, Nancy Bean, Richard Bishop, Chris Braden, Laura Conn, Stephanie DeLong, Sara Ehlers, Cindy Friedman, Patricia Griffin, Peggy Hayes, Mike Hoekstra, Jeff Jones, Malinda Kennedy, Beth Imhoff, Jenny Lay, Deborah Levy, Kathleen Maloney, Paul Mead, Thomas Navin, Oshine Najarian, Robert Pinner, Laurence Slutsker, Cathy Rebmann, Karen Stamey, Bala Swaminathan, Robert Tauxe, Thomas Van Gilder, and Stephanie Wong. California: Sharon Abbott, Mary Ann Davis, Pam Daily, Lisa Gelling, Alexander McNees, Janet Mohle-Boetani, Nandeeni Mukerjee, Joelle Nadle, Jan O'Connell, Gretchen Rothrock, Michael Samuel, Sue Shallow, Ben Silk, Duc Vugia, and Ben Werner. Colorado: Jim Beebe, Steve Burnite, Matt Finke, Ken Gershman, Lucinda Hammond, Sally Hauser, Sean Lieske, Sue Lynch, Ellen Mangione, and Pam Shillam. Connecticut: Gary Budnick, Matthew Cartter, Terry Fiorentino, James Hadler, Robert Heimer, Robert Howard, Sharon Hurd, Kati Kelley, Aristeia Kinney, Ruthanne Marcus, Donald Mayo, Patricia Mshar, Quyen Phan, and Charles Welles. Georgia: Wendy Baughman, Paul Blake, Laurel Boykin, Sabrina Burden, Shama Desai, Monica Farley, Katherine Gibbs-McCombs, Laura Gilbert, Susan Lance-Parker, Susan Ray, Matthew Sattah, Suzanne Segler, and Stepy Thomas. Maryland: Alicia Bustamante, Michael Carter, Yvonne Deane-Hibbert, Diane Dwyer, Lora Gay, Althea Glenn, Charmaine Gregg, Marguerite Hawkins, Kim Holmes, Jackie Hunter, Kelly Henning, Meghan McGavern, J. Glenn Morris Jr., Lola Olabode, Peggy Pass, Jafar Razeq, Jeffery Roche, Dale Rohn, Christian Steiner, Alexander Sulakvelidze, Yongyu Wang, and Frances Yarber. Minnesota: Jeff Bender, John Besser, Rich-

ard Danila, Craig Hedberg, Carlota Medus, Kirk Smith, Dana Soderlund, Sara Stenzel, Ellen Swanson, and Julie Wicklund. New York: Bridget Anderson, Dianna Bopp, Kathy Carlton, Hwa-Gan Chang, Barbara Damaske, Nellie Dumas, Marie Fitzgerald, Karim Hechemy, Jonathan Hibbs, Dale Morse, Candace Noonan, Brian Sauders, Perry Smith, Nancy Spina, and Shelley Zansky. Oregon: Vijay Balan, Chris Biggs, Maureen Cassidy, Paul Cieslak, Emilio DeBess, David Fleming, Bill Keene, Lore Lee, Eileen Lorber, Steve Mauvais, Teresa McGivern, Yijun Pang, Beletshachew Shiferaw, and Bob Sokolow. Tennessee: Effie Boothe, Allen Craig, Diane Eigsti Gerber, Timothy Jones, William Moore, William Schaffner, and Pat Turri. USDA FSIS: Kristin Holt, Noreen Hynes, Tamar Lasky, Denise Lewis, Phyllis Sparling, and Kaye Wachsmuth. US Food and Drug Administration, Center for Food Safety and Applied Nutrition: Ken Falci, Bing Garthright, and Clifford Purdy.

APPENDIX

QUESTIONS REGARDING DIARRHEA IN THE 1996–1997 AND 1998–1999 FOODNET POPULATION SURVEYS

1996–1997 QUESTIONNAIRE

The next set of questions is about diarrhea, that is, 3 or more loose stools or bowel movements in any 24-hour period.

In the past 4 weeks, have you had diarrhea?

For how many days did your diarrhea last?

During this illness...

- Did you have a fever?
- Did you have vomiting?
- Did you have stomach cramps?
- Did you have blood in your stool?

As a result of this illness, were you unable to perform your usual activities, such as school or work (either inside or outside the home)?

1998–1999 QUESTIONNAIRE

The next set of questions is about gastrointestinal illness.

In the past 4 weeks, have you had any of the following symptoms?

- Stomach cramps
- Vomiting
- Fever
- Diarrhea, defined as 3 or more loose stools or bowel movements in any 24-hour period?

For how many days did your diarrhea last?

Did you have blood in your stool?

In the last 4 weeks, did you miss any time from work

because of this illness, for example, because you called in sick or took time off to see a doctor?

Did this illness prevent you from performing school, recreation, or vacation activities or working in the home?

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